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ABSTRACT

This guide presents current scientific research on the process of human learning and stresses the importance of metacognition. Focus is placed on memory and learning with analogies to photography being employed to aid understanding. This guide also includes background information on human memory; a poster; instructions for the four short term memory activities, three emotion and memory activities, eight long term memory activities, three skill memory activities, and two memory games; handouts; and overhead masters. (DDR)

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MEMORY

Acquiring • Editing • Recalling • Forgetting

Nancy Margulies
and
Robert Sylwester

Zephyr Press®
Reaching Their Highest Potential
Tucson, Arizona

Memory
Acquiring-Editing-Recalling-Forgetting

Grades 5–8

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Introduction

One of the best gifts we can give our students is the opportunity to learn *how* to learn, since understanding our own cognitive processes (commonly called *metacognition*) is an important key to becoming a successful adult. To help your students learn how to learn, you can tap the power of all the exciting information that's emerging about our brain and its processes. Scientists are truly discovering answers to many processes that have long mystified our profession, and memory is certainly one such central process.

This learning kit on memory is a companion kit to one on the close related processes of emotion and attention. You can use either kit by itself, but the combination provides the most complete exploration of the related cognitive systems. This memory kit provides you with:

A poster for special memory activities

An audiotape for students to use in conjunction with the poster

This booklet that contains

- *background information on human memory*
- *instructions for memory-related instructional activities that will give you up-to-date information about memory and its role in learning*
- *student-directed activities*
- *handouts and overhead masters*

Begin by reviewing this booklet and familiarizing yourself with the current scientific insights about the process of human learning. Then lead your students in the activities related to the poster and audiotape. Use the handouts and overhead transparencies to instruct your students; you may intersperse the student-directed activities throughout, or you may ask them to choose several to conclude the unit. We have printed two activities to a page; feel free to copy these activities for your class, or laminate one copy of each activity to pass around. You may want to keep a card file of these activities and add your own activities from one year to the next.

The text provides you with many useful analogies and illustrations that you can weave into your instruction over the year. Consider the value of beginning the school year with an instructional unit that develops a deeper understanding of memory and its role in all the learning that will occur during the year, but realize also that the study of memory can easily be integrated into any curricular investigation. However you choose to explore memory with your students, it's important to encourage them to translate the general principles that underlie human memory into an effective and efficient personal memory system that reflects their individual interests, abilities, and preferred learning styles.

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Learning and Memory

A simple way to differentiate *learning* from *memory* is to remember that *learning* is how our brain acquires information, and *memory* is how and where our brain stores it. It's difficult to think of one process without the other, so either term may be used to represent the entire learning and memory process. This kit will use the term *memory*.

The Purpose and Nature of Memory

We wouldn't need memory if we lived our lives totally in the present, in the *here-and-now*. Memory is quite important, however, if we want to use the past to shape the present and to prepare adequately for the future. Similarly, language (the system our social species uses to process many of our memories) isn't necessary for a solitary here-and-now existence. I can climb an apple tree, bask in its shade, and eat its fruit without knowing it as an *apple tree*. I need to label it and its location in time and space if I want to refer to it out of the here-and-now context—for example, to phone a friend who is coming over for a visit and ask, "On your way here, would you get the coat I left under the apple tree in your backyard when I was there yesterday?"

We've tended to think of memory in photographic terms. We imagine that the brain stores a complete picture of objects and events. But our memory is really more like the reconstruction of a dinosaur from a few bones. Scientists with knowledge of the *context* (in this case, the complete skeleton of dinosaurs) can reconstruct an entire dinosaur skeleton from the key bones. They can determine what kinds of bones must have been between the key bones, then fabricate those bones.

Memory is similar. Our brain frequently uses its general knowledge of the world (the context) to fill in the unremembered details between the remembered key concepts. Students won't remember everything they experience in school, but they'll do best if your instruction provides the context, then focuses on the key concepts to which the students can connect intervening details. Imagine trying to reconstruct a dinosaur out of only a few dozen bones. Would we prefer to have only those at the end of the dinosaur's tail, or the same number of bones from various key anatomical areas?

The next time you enter a strange room, note how you get the general idea of the room and its contents through a few quick glances at key elements and unconsciously assume the existence of the rest of the objects. Similarly with events—we don't have to see everything to get a good sense of what occurred. So we experience the world by sampling it, and we use a similar sampling process to remember and reconstruct it. Our brain is thus a conceptualizer—a pattern-seeker in search of the *definitive* elements of the remembered experiences that are especially important to us.

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The Role of Emotion

Our emotional and attentional systems determine the importance of objects and events in our complex environment. Emotion is anything that triggers attention, that is, the unconscious decision to pay attention. Feelings are different from emotions; they are the conscious awareness of our unconscious emotional activational system. Emotion drives attention, and attention drives learning, memory, and just about everything else we do. Thus, emotional involvement is critical to learning and memory.

Think of life as somewhat like a trip in which your car is generally on cruise control, but conditions periodically require a temporary speed-up or slow-down and highly focused attention to pass or to avoid a collision. That's the role that emotion and attention play. They inform us of important opportunities and dangers so that we can temporarily increase or decrease the amount of focused energy we're using to respond appropriately to the immediate situation. After these periods of focused energy, we go back to the more relaxed normality of cruise control. Our emotional system thus contains both an innate and learned sense of the importance of various elements that we continuously confront—danger, fleeting opportunities for resources, strong personal likes and dislikes. Learning begins when our emotional system discovers something worthy of attention.

How and Where Memories Are Stored

Our brain is composed of tens of billions of highly interconnected neurons, cells with tubular axon and dendrite extensions that send and receive information to and from other neurons, sensory organs, muscles, and glands. Neurons combine into complex networks that process everything we do. Some neuronal networks become active when we see or hear something, other networks when we walk or talk—and still others when we think or remember. Some neuronal networks process color, some shape, some movement, some location—and the combination of such simultaneously activated networks can become a mental image of a red ball rolling on a table.

The biology of memory is still ill-understood, but scientists now believe that when a memory is stored within various neuronal networks, physical changes occur within the narrow gap (the synapse) between the axon and a dendrite of interconnected neurons. Neurotransmitter molecules that regulate brain activity pass from one neuron's axon to another neuron's dendrite within this synapse (see figure 1). Memory-related synaptic changes alter the activation patterns of neurons by increasing or decreasing the amount and/or rate of neurotransmitter release. How does this brain biology create mental memory?

Our brain evidently assembles the memory of something (such as a friend's face and a related event) from key relevant fragments of perceptual experience. A close friend's face and name will *jump out* of a room full of human faces because the populations of neural networks in our brain that represent her face and name have been physically reset to activate at a lower awareness threshold than those of a mere ac-

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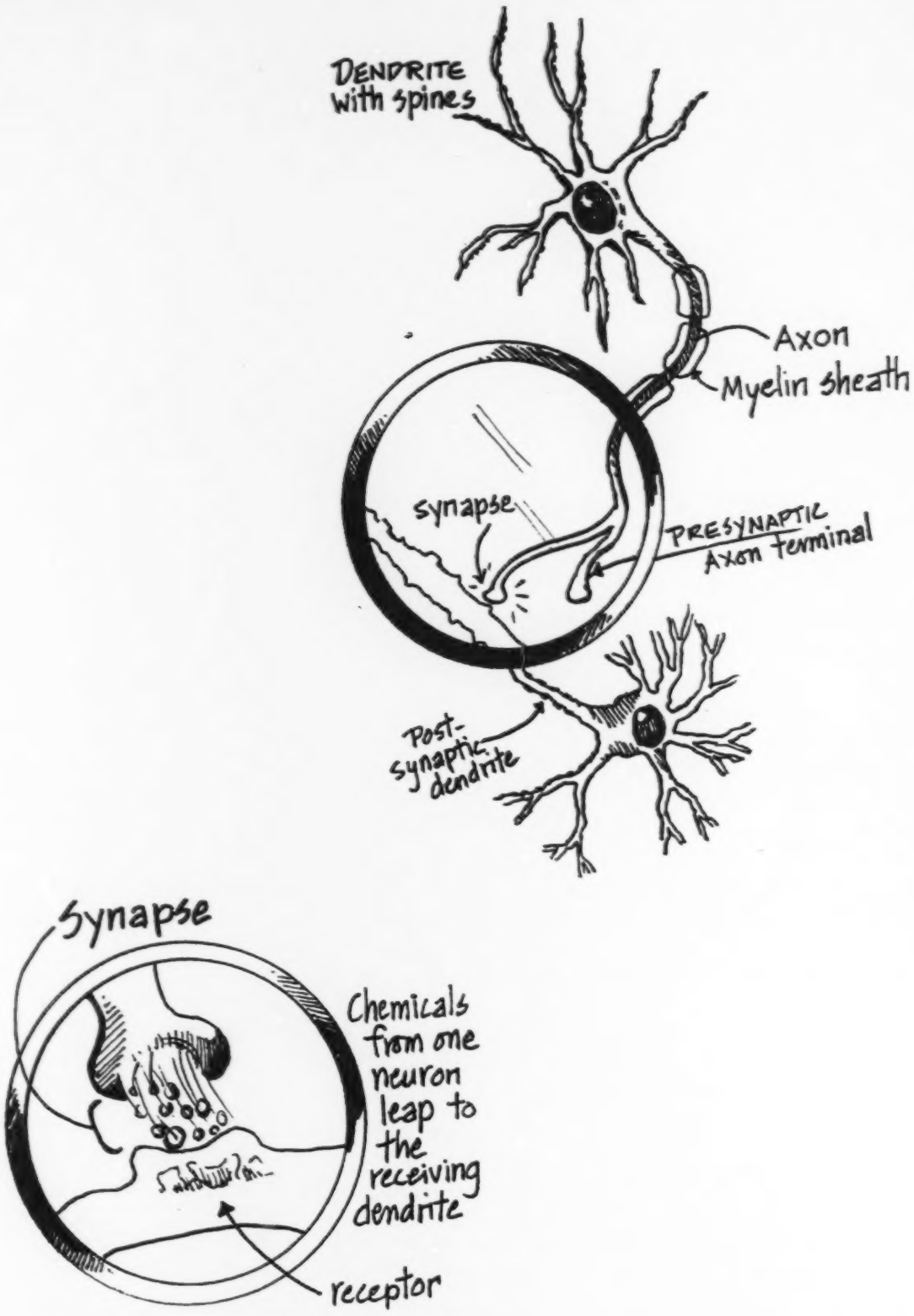
Figure 1: Neurons and Synapses



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quaintance (who may take a bit of conscious action to recall). Think of a thermostat and how it's possible to reset it to a higher temperature to activate the furnace more quickly on a cold day. You have given the thermostat information that causes it to respond immediately to cold air. Similarly, past experience with a friend sets the thermostat of recognition higher, causing a brief glimpse in a crowded room to lead to instant recognition. The strangers in the room will register in our brain only as unknown human faces.

Human memory thus isn't absolute, but rather somewhat elusive. It emerges along a continuum from things easily remembered to those remembered with difficulty, from something remembered instantly to something that pops up in our mind hours after we tried to remember it—and yet it's all considered memory. Think of the dry-to-wet continuum; it's difficult to identify the exact point at which an arid room becomes humid, or a dry surface becomes wet. Similarly, we can think of right and wrong test answers, but many responses aren't absolutely right or wrong.

The Role of Narrative

We tend to use narrative (storytelling) formats to store and recall complex sequences of objects and events. We follow the principles described earlier. We identify and store in memory only the key elements (or the *gist*) of the story in some sensible memory sequence that enhances recall. We generally follow the sequence from what happened first to what happened last. (See figure 2.)

Narrative is an efficient memory system in that each event sparks the recall of the next event in the sequence, much as each domino in a row of dominoes knocks over the next domino. Imagine the additional effort it would take if we had to knock over each domino. Similarly with memory. Related sequential objects and events don't require as much cognitive energy to remember or recall as do those that have to be recalled independently.

When we tell a story, we draw on general knowledge of our world for many of the unremembered intervening details between the key concepts (recall the dinosaur reconstruction). Frequently thinking about and retelling the story helps us to consolidate it in memory so that forgetting is less likely to occur, even though many story details will probably change over time. This phenomenon explains why storytelling plays such an important role in all cultures.

Similarly, we easily remember song lyrics because the melody enhances word recall, providing a powerful context for what comes next. Think of the ease with which small children master the totally arbitrary sequence of the 26 unrelated letters in our alphabet via the "Alphabet Song." If you don't think that the melody helps the process, try to memorize 26 numbers arranged in an arbitrary sequence without the support of a melody.

It's important to use narrative forms in teaching whenever possible to help your students learn and remember. A good narrative provides the critically important emotional context, and the narrative sequence enhances student focus on the mastery of key concepts.

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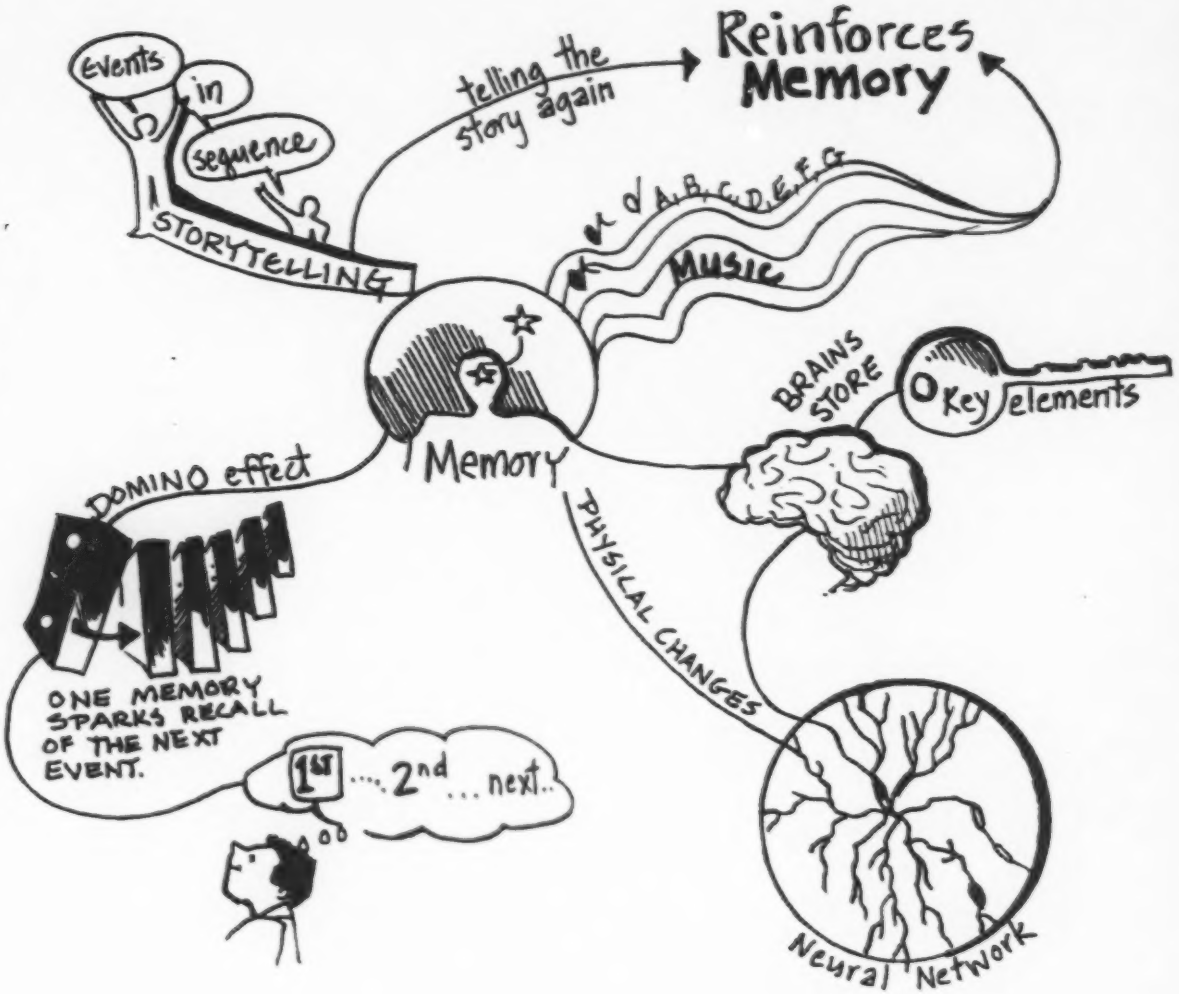
Figure 2: Narrative and Memory



The Role of Sleeping and Dreaming

Sleeping and dreaming are other activities that help us sort out, organize, and test the neural circuitry that processes our remembered experiences. Since memory formation, editing, and forgetting involve physical changes in the relevant neural network connections, it helps to effect such changes during the approximately eight hours each night when we consciously reduce our visually oriented brain's sensory-motor activity. Think of a highway crew detouring traffic while resurfacing a road, or the custodians cleaning the school at night after the staff and students have departed.

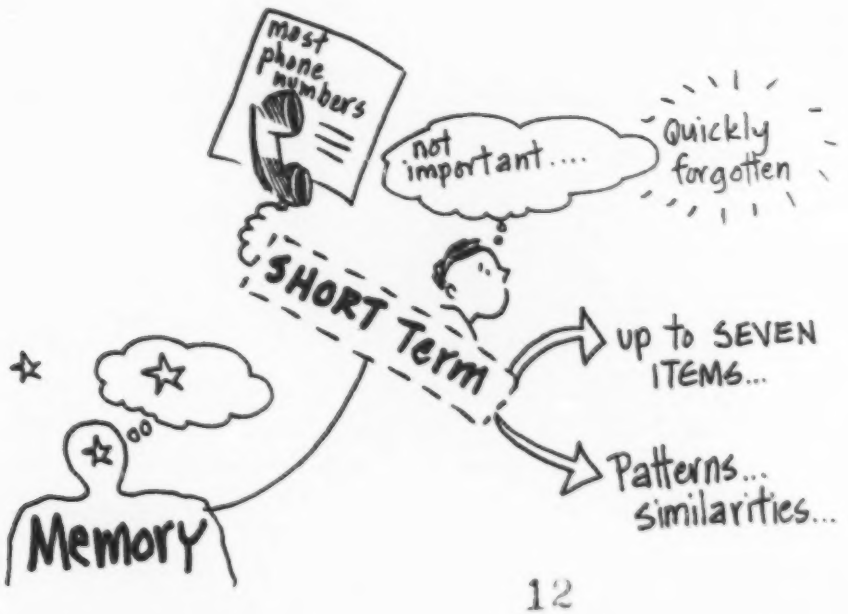
It's not clear what role dreaming plays in memory. Brain activity almost resembles an awake state during our four to five nightly dream episodes (about two hours total time). Some scientists think dreaming involves "circuit testing" the altered memory networks. Others think it erases unimportant information that we had to use during the day.

Cognitive scientists still have much to learn about the specific mechanisms that process the memories that underscore intelligent behavior, but they have defined some key systems.

▶ Short-Term Memory

Short-term memory (or working memory) is an initial fragile memory system that allows us to briefly hold a few units of information that we're currently attending to while we use the information (dial the phone number) or determine its importance (the name of a stranger in a party conversation). We must decide quickly, because the continual influx of new information into our brain will delete anything not consciously held (see figure 3). This limited attentional capacity has survival value because it permits us to completely experience the current situation without having to remember any of it, but also to quickly shift our attention to new situations that might be more emotionally important. Imagine the cognitive overload of a system that remembered every telephone number we had ever called, every person we'd ever met.

Figure 3: Short-Term Memory



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Think of short-term memory as something like the word-processing program on a computer-monitor workspace. Information comes and goes easily on the screen as we type, move, and delete text. A sudden power failure will erase everything, just as a busy signal will generally erase an unfamiliar phone number that we had just looked up and dialed. When the typed manuscript is complete, we save it permanently to disk, just as we insert important information into our long-term memory.

Our short-term memory limitations of approximately seven items require us to rapidly combine (or *chunk*) related bits of foreground information into larger units by identifying similarities, differences, and patterns that can simplify and consolidate an otherwise confusing sensory field. We thus see a face as an entire unit, and not as individual eyes, ears, mouth, nose, cheeks, and hair. This need to respond quickly has enhanced the development of our brain's excellent ability to locate patterns, conceptualize, and estimate. It's a very stimulating cognitive process.

The appeal of computerized video games may well lie in their exploitation of our brain's ability to conceptualize and estimate. They usually lack explicit instructions. Players suddenly find themselves in complex electronic environments that challenge them to quickly identify and act on rapidly changing elements that may or may not be important. Failure sends the player back to the beginning, and success brings a more complex albeit attractive challenge in the next electronic environment. Classroom discussions, debates, and games often provide a similar level of stimulation.

▶ Long-Term Memory

Memory researchers now differentiate among emotional, factual (also called declarative or explicit), and skill (or procedural or implicit) long-term memories (see figure 4). Factual memories are *what happened*, and emotional memories are *feelings we have about what happened.* Mastered skills are *unconscious processes.* For example, we speak with no conscious awareness of moving the muscles involved.

Emotional memories reach our consciousness as feelings and body states. As indicated earlier, they trigger our attention, then initiate a memory search for relevant related objects and events. The characteristic body state of a remembered emotion isn't the same thing as consciously remembering a prior emotional experience. Compare the grief felt at remembering the death of a parent or the happiness at remembering winning an important game with being able to recall when and where the death occurred or the final score of the game.

Our emotional memory is a critically important cognitive system that is apparently processed separately from factual memories. Two brain areas that seem to play important roles in processing emotional memories are the *amygdala* (two small, almond-shaped structures located deep inside our brain) and the frontal lobes of the cortex (the cortex is the large, deeply folded neuronal sheet at the top of our brain; the frontal lobes are the area in front of and over the head ear-to-ear line). Figure 5 is a depiction of these brain areas.

Figure 4: Long-Term Memory

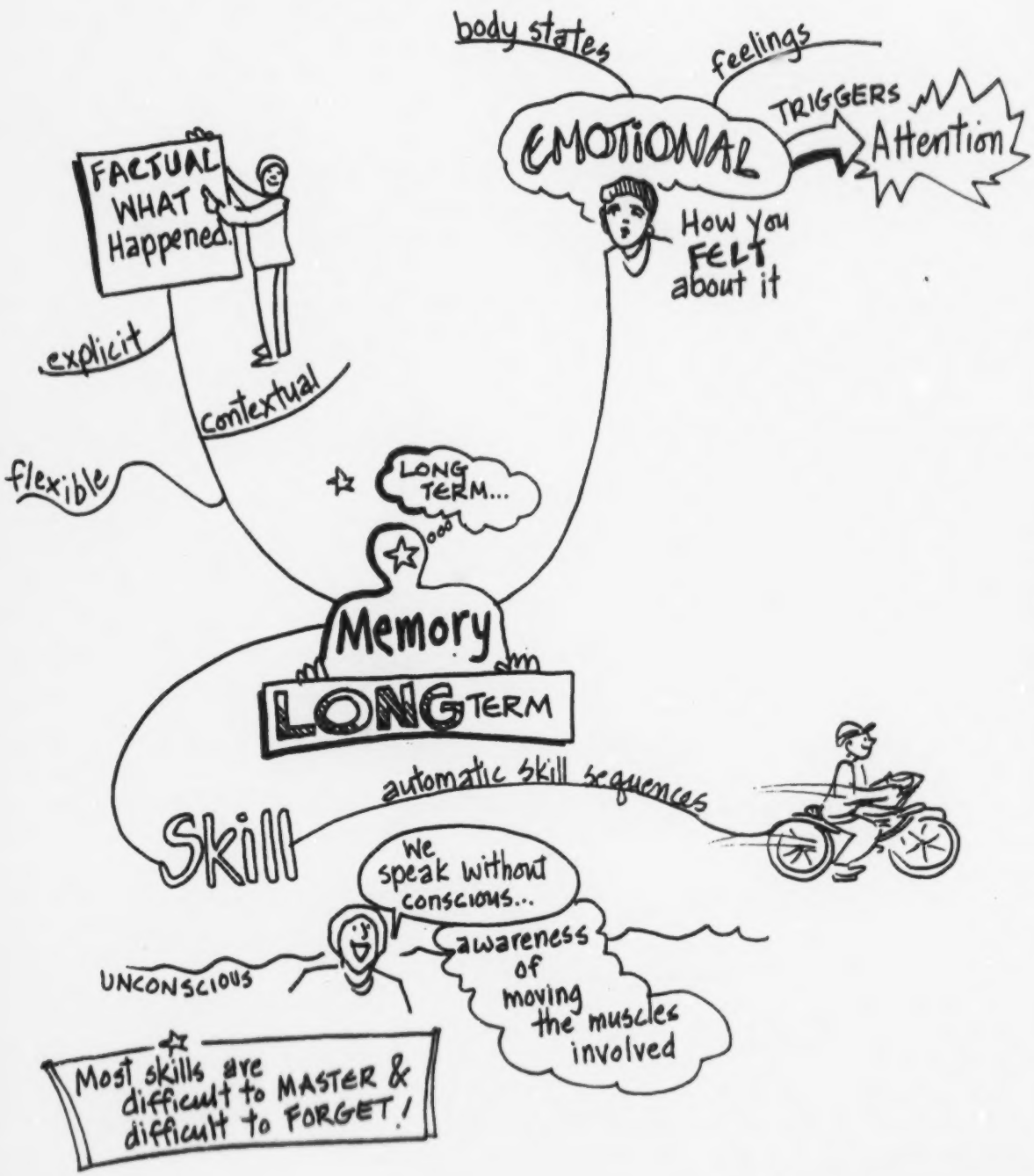

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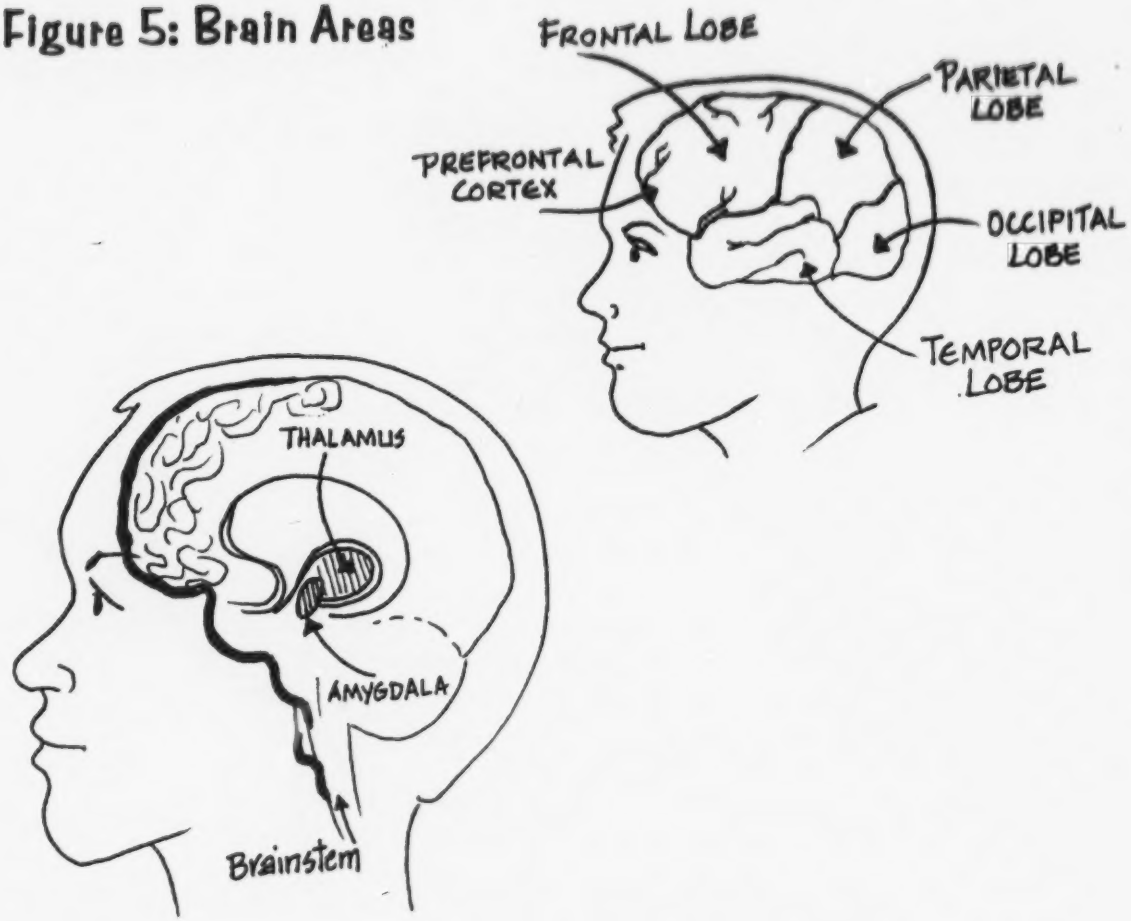
Figure 5: Brain Areas



▶ Factual Memories

The *hippocampus* (two seahorse-shaped structures that adjoin the amygdala) and the entire cortex process such factual label-and-location knowledge as the brand of my car and where it's located. They define named categories and so are verbal and conscious. *Episodic factual memories* are very personal, intimately tied to an emotional setting (taking my driving test, getting a ticket). *Semantic factual memories* are more abstract and symbolic (knowing driving laws and the symbols on road maps). They represent a category of information and so are not tied to a specific context, but can be used in many contexts.

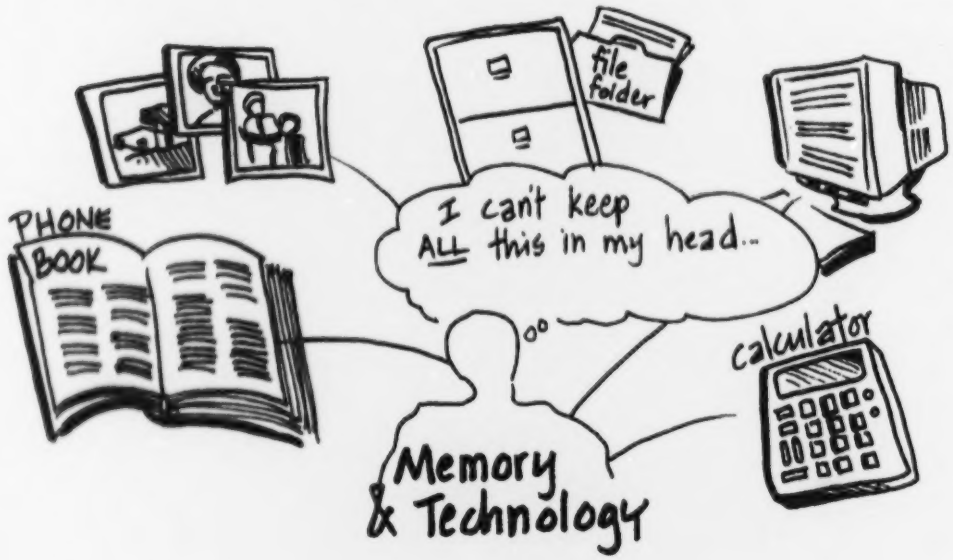
Factual knowledge develops best when our brain's relevant networks make time and space associations with the various elements of a perceived object or event (for example, my new car is red, my previous car was blue). Factual learning is thus contextual, instrumental, and flexible (easily learned and forgotten). For factual information to be useful, our brain must connect it to an environmental setting and challenge.

As all teachers discover when they read test responses, factual memories are subject to error and distortion.

▶ A Useful Metaphor for Factual Memories

When we humans are overwhelmed by information and challenge, we tend to reinvent the related body/brain process outside of our body, and let that technology carry the load. Examples include phone books, dictionaries, calculators, and photographs (see figure 6). Thus, in our search for a simple explanation for emotional and factual memory, it's useful to examine the systems outside of our skull that we've developed to store and retrieve complex combinations of information.

Figure 6: Systems That Remember for Us



The combination of file cabinet, file folders, and files might be a useful metaphor for memory—one that students easily can understand, since it has many parallels to what our brain actually does as it gathers, organizes, stores, retrieves, and uses information.

Think of our brain as a reasonably full and useful file cabinet. Think then of an emotional memory as a file folder (within a cabinet drawer) that contains many files—the factual memories of objects and events related to the emotion. When we pull out a file folder, we have easy access to all the files within it. When the file folder is in the file cabinet, though, we don't have easy access to the files.

It's useful to limit ready access to many of our factual memories to situations in which we're in the time/space/emotional *neighborhood*. Imagine a trip to the down-

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town area of a city we've visited, but not recently. Before going, we may have trouble recalling specific locations, stores, cafes, and so on, but when we arrive, many factual memories easily return. The emotional state of being there automatically pops out the file folder and we have ready access to the factual information we need. Imagine the cognitive overload if we had continuous easy access to all such memories even when we didn't need them, when we weren't in the neighborhood. Or think of a class reunion and how we effortlessly recall long dormant memories of people and events, or the instant recall of prior related negative experiences during an argument with a spouse or friend.

We thus have best access to weak factual memories (the files) through strong emotional memories (the file folders). Factual memories without emotional context are difficult to store and retrieve. The name-date-place kinds of curricular information we ask students to remember are a good example. Students often ask, "Will this be on the test?" and if the answer is "Yes," they have a useful *emotional file folder* for the information, "Test Things." During the test, they'll pull out and use the file folder and its information—but since the information is stored in the test file instead of in a file that reflects real-life context, the student may not be able to access the information in another context. In other words, students often associate the facts with the test rather than with cultural utility. That's why it's so important to provide an emotional and cultural context to most of the topics you teach.

School simulation and role-playing activities provide a useful emotional context (or file folder) because they are related to real-life emotional uses of the information. Conversely, multiple choice (and related) tests generally mask the context of factual information. As indicated earlier, students who pass the test may still be unable to use the information in its cultural context.

If the emotional overtones of an experience are very important, we may create especially strong emotional and weak factual memories of the event. Thus, an abused child who must continue to live in an abusive situation may be better off focusing on aversion strategies than on remembering all the details of past abuse. A strong related emotional stimulus years later may then trigger the recall of these weak factual memories (as with long dormant class reunion memories).

Mass media, marketers, politicians, and special interest groups often exploit our emotional/factual memory system by hammering us with emotion-laden terms and images that they design to pull out emotional file folders biased to their position. Two such placard-waving groups with opposite views on the issue of Internet regulations recently appeared in the same newspaper picture—one waving a sign with the message *Stop Child Pornography!* and the other *Protect Our First Amendment Rights!* How newspaper readers will contemplate the issue will depend somewhat on which *file folder* pop up in individual readers' minds upon seeing the picture—and whether or not the "facts" supporting the position are seriously biased.

Even if we don't already have an emotional file folder for an issue we confront for the first time (such as the recent unexpected announcement of a successful cloning), we tend toward an almost immediate emotional response. Think of the organization of a library. If the book we seek is gone, we usually examine the two adjacent books,

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because libraries are organized so that the two adjacent books are always the closest in focus and content to any shelved book. Similarly, when we confront a novel challenge, our emotional system tends to begin our response sequence with something we consider similar. In the case of cloning, perhaps the Nazi genetic experiments, science fiction, religious beliefs, a love of science, or the novel *Brave New World* initially popped out in your mind. The emotional file folder had more to do with whether you perceived the event as positive or negative than did the actual facts of cloning.

Skill Memory

Skill memory involves mastery of automatic sequences and is more context-free than the factual memory. Touch typing, swimming, and mastery of multiplication facts are examples of skill knowledge that can be used in a wide variety of situations. It thus becomes important to free such remembered information from the constraints of a single emotional context (or file folder).

Think of learning the multiplication tables. Teachers tend to create an initial emotional context in hands-on math—for example, six boys with five pencils create an array on the table, and the students add it up to 30. The teacher then asks six girls to do it and it comes out the same, as it does when six students use paper clips or anything else. The emotional context thus becomes irrelevant when the students discover that 6 of anything times 5 of anything always equals 30. The multiplication tables are thus mastered free of context, so that they become automatic memory and can be used in many different contexts. Spelling list words, freed from the context of a specific sentence, can similarly help students discover ways in which words can be used in many different contexts, if you make this connection.

Automatic skills are processed principally by the *motor cortex* (a narrow ear-to-ear band over the top of the cortex) and the *cerebellum* (the bump at the lower back of our brain). Skills are difficult to master and to forget. When learning to drive a car, you were probably very conscious of all the navigational equipment and weren't a very good driver. With practice, your factual knowledge of the equipment became an automatic skill. Today, you probably drive with little conscious awareness of the equipment (except during crisis conditions) and are a much more efficient driver. A foolish test of your driving ability would be a written test on the names of the navigational equipment.

The effective combination of emotional, factual, and skill knowledge can provide us with a powerful cognitive tool that David Perkins (1995) calls *knowing our way around* the various realms that we confront in life—knowing our way around airports, restaurants, a used car purchase, a leaking faucet, a bureaucracy. All such challenges require more than merely being emotionally concerned, knowing *that* (facts), and knowing *how to* (skills). They suggest a dynamic functional relationship among the various memory components. They also suggest that our memory is a far more complex and emotionally driven system than we had previously thought.

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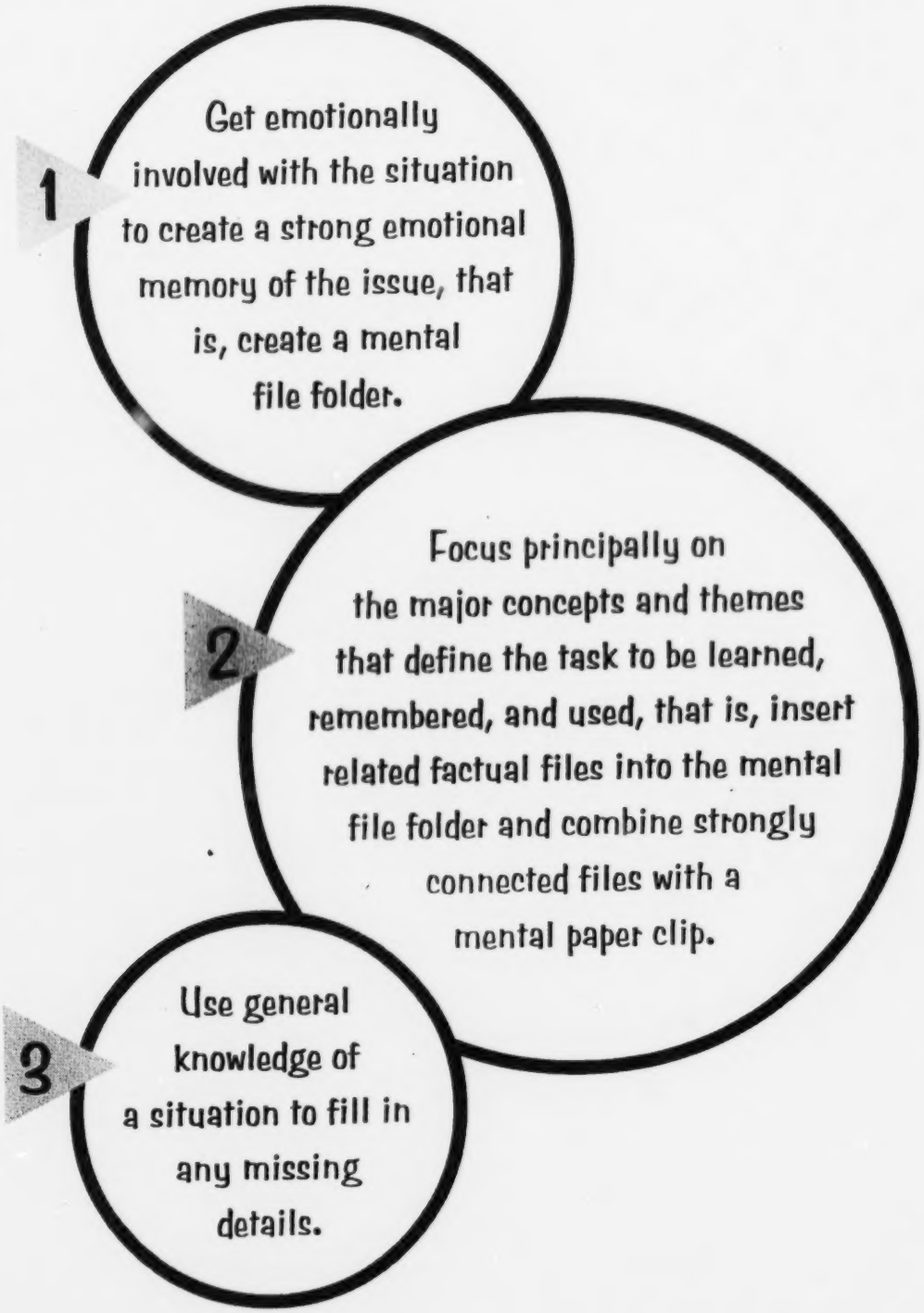
How to Increase Memory Ability


1
Get emotionally involved with the situation to create a strong emotional memory of the issue, that is, create a mental file folder.
2
Focus principally on the major concepts and themes that define the task to be learned, remembered, and used, that is, insert related factual files into the mental file folder and combine strongly connected files with a mental paper clip.
3
Use general knowledge of a situation to fill in any missing details.

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Discussion Questions

The following questions are designed to spark class discussion and further exploration about our memory processes, rather than to result in definitive correct answers. Rephrase them, if necessary, to enhance your students' discussion capabilities.

1. Why is it difficult to remember things that occurred before the age when you began to learn to talk (usually about two years old)?
2. Why was it easier to learn the alphabet by singing the alphabet song than if you had tried to learn the sequence of all 26 letters without singing? Put the letters in a different sequence and try to learn the alphabet without singing.
3. Why is it often easier to remember and tell an entire story than to write a few words in response to a test question?
4. Why is it often difficult to remember something important, only to have it suddenly pop up in your mind after you quit thinking about it?
5. Why is it usually easier to remember the main topics of something you studied than the specific facts?
6. Why do you think it's easier to recall something that's important to you rather than something that's important to someone else (such as a teacher or parent)?
7. Why can you usually recall some very emotional event that occurred to you only once, but have difficulty remembering factual things that don't affect your emotions?
8. What similarities and differences are there in our memories of smells, sounds, sights, touches, tastes?
9. What are some things that plants have to *remember* to do from year to year (such as to drop their leaves in the fall)? Scientists don't believe that plants have a memory system like ours, but what sort of a system might they have that enables them to carry out their functions over time?
10. Ask students to recite the names of the months in order from first to last. Then have them say the months from last to first. Finally, have them say the months in alphabetical order. Why is it easiest to say the months in order? Why is it more difficult to say them backward? Why is it much more difficult to say them in alphabetical order?

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Teacher-Directed Activities

The Memory Poster Activity

The following activities serve to entice your students into their study of memory. You might decide to do all of them, or you might decide to pick and choose. These activities can be copied, laminated so they remain presentable, and kept in a binder or card file for use in future years. Add your own activities as you think of them. Students can even collaborate to make an audiotape or poster for their own use in future years.

Step 1: Place the poster on a wall of your classroom. If your students ask you about it, just say that it relates to an activity you will be introducing later.

Step 2: After a couple of weeks have passed, remove the poster. Ask your students, "Who remembers what was on this spot on the wall? What exactly do you remember?" Encourage them to come up with as many details about the poster as they can. Ask them to list the details as a whole class, as individuals, or as partners. On the board, list each element of the poster that students remember. Discuss why certain items might have been memorable. The goal of the discussion is for students to develop their own theories about memory, using their own memories of the poster as a source of insights. They might notice that some memories are linked to personal preferences, emotional ties, or past experiences. They might discover that the elephant with a big seven on its side is memorable because it is unusual. The candy might have evoked a positive and familiar memory for some students. If someone in the class owns red tennis shoes, she might be more likely to have noticed and remembered the pair on the poster.

Ask students to close their eyes and see if that helps them remember more of the poster. Our memories work through a process of association. As students recall one aspect of the poster, are they led to remember another?

After the students have recalled all they can about the poster and have discussed why they might have remembered certain aspects of it, place the poster on the board next to the list. How accurate were their memories? Did any one notice the objects floating around grandmother's head? These objects represent the fact that we don't store information all in one part of our brain, like complete photographs. Memory is distributive, so when we see a face, we are gathering memories about round objects

(grandmother's glasses) from one part of our brain, memories of color from another, and bringing them all together to form a complete memory of grandmother's face. There is more detail about this phenomenon on page 5.

Step 3: On side 1 of the audiotape is a story that will make sense of each aspect of the poster. If you have the opportunity to divide the class into two groups in two separate rooms, you might experiment with the tape. If you need to keep your class together in one room, skip to step 4.

Ask half the class to listen to the tape while the other half goes to a different room to memorize a list of facts (compile your list of facts from those beginning on page 26). The group that is given the instructions to memorize can work together or separately, using any method of memorization they wish. The list they will be given contains the same information as the story on the tape.

Step 4: When both groups have completed their tasks, bring them together. You can use the information in this booklet (pages 26–28) to create a quiz, ensuring it suits the skill level of your class. Ask all students to answer as many of the questions as they can. The goal of this activity is for students to learn about memory and what makes information more memorable. The group who memorized a list can work together, combining their memories to come up with as many correct answers as they can. The group that listened to the tape can do the same. The goal is not to test individuals as much as to *discover* what makes information more memorable.

Step 5: Ask students to tabulate the results. Which group remembered more details? Why? Explore through a class discussion what aspects of the tape enabled the group that listened to it to remember more facts. Some aspects of the tape that they might list follow.

Repetition

Notice how the narrator repeats many of the facts.

Emotion

A grandmother is a useful link to the past for students who are beginning their normal puberty-driven search for independence from their parents. Most want to know where they've been to enhance their trip into the perhaps-scary future. Grandparents can be helpful in this transition, and this Grandma is a bit of a rebel with her own identity and independence. Further, grandparents know what happened to a student's parent during the same years, so encourage your students to talk with their grandparents during this unit.

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The feelings about their own grandmothers, worry about Grandmother in the story, suspense, delight at finding her are all aspects of the story that may trigger feelings or memories students already have filed away; these may relate to concern over someone they care for, worry about not knowing what is going on, or the discomfort of being uncertain. Positive emotions also evoke memories. Many students may remember the candy on the poster because they like the sight, taste, and smell of candy.

Grandmother's interest in elephants comes from her positive feelings about them and her fear that they may soon be extinct, as well as her anger at the poachers who kill them. These emotions lead Grandmother to notice and remember a great deal about elephants.

▶ Narrative

When information is in the form of a story it becomes more memorable. We can link and connect elements of the story, bring our emotions into play, and relate a great deal of information in a way that holds our attention. In fact, before we had the ability to create books and other written documents, all the important information and beliefs of a group of people were passed on from generation to generation through stories.

▶ Unusual Events

When something out of the ordinary occurs, it grabs our attention. Our brain is designed to keep us alive and one way to stay alert for survival is to notice anything new or "out of place" in the familiar landscapes of our lives. A giant numeral 7 painted on the side of an elephant is unusual! Grandmother wearing red tennis shoes and sitting in a rocker that is missing a leg is unusual, too.

▶ Familiarity

Just as unusual items may catch our attention, familiar aspects of a story serve a purpose in memory, too. They enable us to link the new information or ideas that we hear with memories that are already stored in our brain. Since many of us have grandparents who are important in our lives and many of us have visited a zoo, we can link these familiar experiences with new information in the story.

▶ Comedy

Situations or events that make us laugh can release chemicals in our body and brain that lead to positive feelings. If Granny sitting next to an elephant in her red sneakers saying "I am a stand-in cow!" seems funny, it just might stay in the memory longer.

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Visualization

When we can imagine information in the form of pictures or scenes, we can more easily remember it later. This process of associating new information with visual images is demonstrated in the tape by the five laws of great detectives, each of which is linked with a picture in the storyteller's mind.

Music

The tune and lyrics of songs are memorable to most people. As adults we can frequently remember an entire song from years ago just by hearing a few notes of it. Some people can remember every word of their favorite songs thirty years later—even if they have forgotten most of the details of the year the song was popular. The song that is sung and rapped in the audiotape gives the students a chance to hear and recall many facts.

Additional Discussion and Activity Suggestions

- Ask students, "When called upon to learn new information, what strategies can you use to make the information more memorable?" Examples include weaving the facts to be learned into one story, creating a rap or song that includes them, making posters or Mind Maps that contain key elements, writing the facts in colorful and unusual forms on cards and playing a game using the facts. Mind Maps or mindscapes are another tool for learning and greatly improve memory. The illustrations in this book are examples of mindscapes. These visual records use key words and phrases as well as arrows, pictures, and other symbols.
- Create a challenge for students by asking them to get into small groups and make up a new story that uses each element of the poster.
- Ask older students to use the poster and tape to create a lesson on memory for younger students in another class. Give the group who memorized facts from a list time to listen to the tape and discover how the story makes the information more memorable for them before they create the lesson.
- Ask the group who heard the tape to use the poster as a memory aid and tell the story to the group who memorized facts without hearing the story.
- Ask the class to discover what's wrong with the poster. *Is Granny off her rocker—or is her rocker off?* The answer is that Granny's rocker is missing a few key structural elements—it would never rock! The student who notices the missing element is exhibiting visual-spatial intelligence. Once you notice that the rocking chair is highly unusual, do you think it will make the rocker more memorable?

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Alternative Activities

1. After playing the tape, ask your students to jot down at least ten facts from the tape. While a team of students quickly tabulates the results, ask the rest of the class to pair up and retell the story to each other with as much emotion as possible (perhaps stopping the group every 30 seconds to let the other student continue the story for the next 30 seconds). If the tabulating group isn't done when the other students have completed their retelling, discuss the retelling experience: Were new elements inserted into the story? Which elements were left out? And so on.

   Examine which facts from the poster were most and least remembered, and compare the results with the results of the test students took before they heard the tape. This activity could lead to an interesting discussion of the relative difficulty of learning and remembering school facts that are imbedded in narrative compared to those that aren't. As a result of students' new understanding of how memory works, you might engage them in designing their own curriculum ideas or study plans. Doing so invites students to become more involved in their own learning decisions.

2. Replay the tape and ask groups of students to imagine themselves at various emotional distances from the girl and her grandmother—the granddaughter's parent, the grandfather, the last person who was with Grandmother before she became a missing person, someone merely visiting the zoo at the same time, the zookeeper, someone who read the newspaper account, and so on. Discuss differences in their emotional involvement in the story. Students could actually retell the story from the point of view of one of these people, adding as much drama to the telling as possible. One student could be a reporter who interviews several key people.

3. On the board, list ten or so seemingly unrelated elements, somewhat like the items on the poster. You might ask students to volunteer items. Then ask students to pair off. One student invents a story that uses all the elements; the other student attempts to repeat the story. Discuss the results with the entire class. Which elements were easier to insert into the story and remember? Which elements were less so?

4. Ask students to select an event in their lives. It could be an important event or something as simple as a recent shopping trip. Ask them to close their eyes and recall as much of the event as they can: What do they see? How were they feeling during the event? Who else was there? As they recall the event, ask them to fill in as many details as they can. Can they see their individual events as a film or TV show? Are they in the scene or out of it, merely viewing what occurred or looking through their own eyes and reliving it? Is the memory more like a picture or a feeling? As they remember one detail, does it spark another? Ask students to discuss the experience in groups of three or four. They can then list aspects of memory to share with the entire class.

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The Audiotape

On side 1 of the audiotape you will find the story of the missing grandmother. The facts and ideas contained in the story might make an interesting memory quiz for your students. You might include the five elements of a good detective, elephant facts, or some other items. (See the list of facts from the tape and additional, related facts beginning on page 26.)

On side 2 of the tape you find the following:

- An invitation to students to experiment with the relationship between song and memory. Song can be a valuable memory tool. Consider that toddlers learn nursery rhymes and songs, and by the time they start school, most children know the letters and random sequence of the alphabet because they heard it as a song. The tape invites students to experiment with the relationship between song and memory by listening to the elephant song several times. Encourage them to do so while they are engaged in other activities, such as cleaning up around the classroom (don't you wish!) or working on art projects. The song will become familiar and the words will enter their memories without them consciously concentrating on trying to memorize it.
- An explanation of the relationship between our senses, emotion, attention, and memory. Pages 43–49 illustrate this process; copy them onto transparencies, or use them as posters or handouts. After you discuss their content, play the tape as a reinforcement. You may wish to play the tape first and use it as a trigger for discussion.

The elephant song is printed here so you can use the facts in your classroom activities.

African elephants are big and strong—
Trunk to tail, 24 feet long.
Back slopes down with giant ears,
Poachers in the wild are their greatest fears.

Tusks, like teeth, are long and strong,
Growing from the elephant where they belong.
But ivory tusks are worth a lot,
And full-grown elephants are being shot.

Left alone with no parents to guide,
Baby elephants take a slide,
Hanging out with only others their age;
They often go on a complete rampage!

What can you do to help them endure?
Don't buy ivory, that's for sure.
What can I do to help them endure?
I won't buy ivory, that's for sure.

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You might discuss with your students the facts embedded in this song and add any facts that seem related. For example, African elephants have large ears and backs that slope down. Asian elephants, on the other hand, are usually smaller, with backs that are rounded and ears that are smaller.

Tusks are really teeth, made of ivory. The ivory is valuable and has caused elephants to be killed for their tusks. *Poachers* is the term used to describe those who kill animals illegally. Most of the hunting for fur, hides, and animal body parts (including tusks) is poaching. When the young elephants have no adults in their family, they frequently go on rampages and destroy property. How does this compare with what happens in human society?

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Facts for List, Quiz, and Related Activities

The facts and ideas contained in the story and the rest of side 1 of the audiotape follow. You might create a list of facts to have students who don't listen to the tape memorize. You can create a quiz from the following information, as well.

- Jackson Jones is the name of a boy who reads detective stories.
- According to Jackson, there are 5 rules of great detectives:
  1: *Picture success; when President John Kennedy suggested putting a man on the moon, he was picturing success.*
  2: *Become the mystery: take a different point of view.*
  3: *Leap to no conclusions: keep an open mind.*
  4: *Leave no stone unturned.*
  5: *Two heads are better than one.*
- There once was a girl whose grandmother was very unusual.
- She wore red high tops.
- Grandmother owned a picnic basket that contained two thermoses.
- She also owned two toothbrushes, one normal, one giant, which she claimed was for elephants.
- Grandmother's father was with the state department.
- They lived in Turkey and West Africa.
- *Pachyderm* is a thick-skinned animal such as a rhinoceros or an elephant.
- At one time, there were 600 different kinds of elephants in the world.
- Now only two species of elephant exist: Asian and African.
- The Asian elephants are smaller, with ears shaped like India and backs that are rounded.
- Africans have larger ears that are shaped like Africa and backs that slope down.
- Elephants can use their ears to keep cool. When they flap their ears, it cools the blood in the vessels in their ears.
- Both male and female African elephants have tusks.
- Elephants grow to be 24 feet long.
- They weight up to 7 tons.
- An adult elephant can drink 30 to 50 gallons of water a day.
- Elephants can go without water for up to 3 days.
- Tusks are actually giant teeth made of ivory.
- Poachers shoot elephants and cut off their tusks.
- When baby elephants are left without adult guidance, they often go on rampages.
- It is estimated that only half a million elephants remain in Africa and Asia.

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- Elephants go through 6 sets of teeth during their lifetimes because their diet is coarse.
- A cow is a female elephant.
- Elephants are pregnant for 22 months.
- Elephants suck water up the trunk then squirt it into their mouths.
- Newborn elephants weigh 200 pounds.
- A few hours after being born, baby elephants can stand and nurse.
- They nurse with mouths (not their trunks) until they are 3 years old.
- Poachers kill animals illegally; they are often after the animals' fur or body parts; in the case of elephants, they are after tusks.
- It's illegal to kill elephants for ivory.

Related Facts

Following are more detailed, related facts that you might wish to include:

- African elephants' tusks are larger than those of Asian elephants.
- African elephants' backs curve down in the middle; their foreheads are flat and sloping.
- Asian elephants' backs curve up in the middle; their foreheads have two prominent bumps.
- The male elephant is larger than the female, up to 24 feet long.
- Asian elephants are smaller, shorter, and wider. Only the males have tusks.
- Tusks are elongated teeth made of ivory (like our teeth without the enamel covering). There is a ban on ivory trade, yet many poachers still kill elephants for the tusks. They use guns or spears and sometimes leave the elephants to die a slow death.
- The African elephant was placed on the most endangered species list in 1990. A ban on the trade of ivory has been imposed in many countries as a result of a worldwide effort and a meeting of the member nations of the Convention on International Trade in Endangered Species (CITES). Since 1990, the price of ivory has dropped tremendously; however, a few countries, such as Zimbabwe, does not recognize the ban.
- The destruction of forests to make room for crops is inhibiting the growth of elephant herds and in some cases destroying existing herds. This destruction also creates *pocket herds*—herds that are cut off from the wide open ranges. These herds damage their remaining habitat and the farms in their search for enough food.
- Answers to extinction include building safe watering holes and relocating herds before developing their habitat.

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Possible Vocabulary Words for This Unit

hierarchy: The categorization of a group according to ability or status

Context in Program: "Sparring between the young males establishes a hierarchy that the animals remember and respect throughout their lives."

ivory: A hard, smooth, yellowish-white substance composed primarily of dentine that forms the tusks of an elephant

Context in Program: "The prize is ivory, the price is extinction."

matriarchal: A type of social system in which the female is the head of the family or social group

Context in Program: "Elephant society is matriarchal."

poachers: Those who hunt or fish illegally

Context in Program: "They cannot defend themselves, however, against the poacher's bullets."

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Student Exploratory Activities

We have printed the following activities two to a page to facilitate photocopying. You might choose to make several copies and hand these out to your students. Or you may laminate one copy and pass it around. Whichever method you choose, we suggest that you keep a file, either in a binder or a card file, of these activities for easy reference and to add to over the years.

Ask individual and groups of students to do the following activities to explore and report on various dimensions of our memory systems. Encourage them also to develop their own memory experiments.

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Short-Term Memory Activities

This experiment tests your classmates' ability to remember a small amount of information for a short period of time. Write the following letters and numbers on two large cards or an overhead transparency:

B E H D	6 3 8 1
D L U N	4 2 9 0
A P F G	5 4 7 3
X K R I	9 1 0 8

Give classmates 30 seconds to memorize the letters and numbers. Ask them to write the letters and numbers and score how many are correct. Tabulate the results. Do they do better on letters or numbers? What strategies did they use to memorize the letters and numbers?

Without telling them in advance, two hours later ask them to write down the letters or numbers. How well did they do this time? Suggest reasons for the differences.

What happens to the scores when you add two letters and numbers (50 percent more) to each row? Do they make 50 percent more errors or even more than that?

N D E T Y G	5 3 8 1 0 7
X R U I W P	2 6 0 3 1 6
Q B M A C K	0 4 2 8 7 9
Z E U F M D	1 5 8 5 3 4

Repeat the experiment with the following more easily remembered patterned letters and number sequences. Ask them to explain why they did better or worse.

B A N D	2 4 6 8
L E A N	9 6 3 0
O P E N	1 2 8 9
L I N K	1 3 5 7

Report the results to your class.

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Short-Term Memory Activities

Place ten unrelated objects (scissors, pencil, paper clip, book, and so on) on a table in a corner or another room. Divide your class into three groups and ask one group to observe and memorize the objects within 30 seconds as they stand around the table. Then ask them to look away and then quickly write down the objects. Tabulate the results.

Ask the second group to memorize the same objects while you read a section of a story or poem to them. Ask the third group to do it while they are also writing their names five times on a sheet of paper. Arrange things so that your classmates don't discuss the experiment with those who haven't yet participated. Compare the results from the three groups and report to the class. How much did the distractions for groups 2 and 3 affect their ability to learn and recall?

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Short-Term Memory Activities

Develop and type a humorous story with as many (reasonably short) sentences as you have classmates. Number the sentences, and cut up the sheets of paper so each sentence is on a strip. Pass out the numbered sentences to the class (in order around the room). Give them 30 seconds to memorize their sentences, then ask your classmates to quickly tell the story by repeating each memorized sentence when their individual turns come up (as you point to them). Did the story itself help them remember their sentence? Did anyone change the sentence?

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Short-Term Memory Activities

Locate a room in the school that students rarely enter (such as the storage or furnace room). Without describing the total experiment, ask five or so classmates to enter the room and look around for 30 seconds. Ask them to turn around quickly, leave, and write seven specific things that they observed. Compare the lists to discover which objects all mentioned, which only a few or one mentioned, and which no one mentioned. Discuss your findings in terms of our ability to quickly identify the important elements of a new situation. Did you and your classmates combine (or chunk) related objects into larger classifications?

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Emotion and Memory Activities

Slowly read the following list of words to your classmates and ask them to quickly write down the first word that comes to their minds after hearing a word:

pizza	snow	computer	green	automobile	birthday
quickly	fourteen	summer	school	dog	book

Examine their responses to discover how many of them describe objects (nouns), actions (verbs), and qualities (adjectives/adverbs, such as beautiful/big/fast). Give your classmates an opportunity to explain their responses to one of the words. Report and discuss your findings.

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Emotion and Memory Activities

Ask your classmates to (1) ask their parents to tell what they remember of the year that they were in the same grade that you are now in, and (2) to write down what their parents said. Develop a class report on what your classmates report their parents said. Do they tend to mention the same things or do their memories differ? Do they remember things that are also important to you and your classmates?

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Emotion and Memory Activities

Find a poem that you like that has forty or more lines and recite it to the class after you've memorized it. Tell your classmates how you went about selecting and memorizing the poem, and how much your enjoyment of the poem helped you to learn it. Did the poem tell a story that also helped you to learn it?

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Long-Term Memory Activities

Ask your classmates to write down something that they can remember from each year of their lives. Examine their papers and note any patterns in the kinds of things they listed, which years caused them the most trouble, and whether the things they remembered tended to be very important things or just some odd event that somehow stayed in their memory. Another way of doing this activity is to ask them to remember a specific school event from each of their school years. Report your findings to the class.

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Long-Term Memory Activities

It's important not to tell your classmates how this project will end until the final day. Use a marking pen to write the numerals 1 through 15 down the side of a long sheet of butcher paper affixed to a wall. At the end of each school day for three weeks, use six or fewer words to write down something that happened that the class thinks they will remember, such as *Field trip to the mall* or *It rained all day.* When you have made the fifteenth entry on the third Friday, roll up the sheet after school. On the following Monday morning, ask your classmates to write down the fifteen items listed on the sheet. Tabulate the results and report your findings. Which things (and which kinds of things) were most and least remembered? Did they do better with the earlier or later things on the list?

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Long-Term Memory Activities

Select a news story with much local interest, and gather all the information you can on it. Develop a list of six or so important facts related to the story, and use about ten minutes of class time to teach the information to your classmates in the most interesting way you can. One week later, give your classmates a test on the facts that you have taught them. Tabulate the results and discuss the findings with the class—which facts were most and least remembered, and possibly why. Ask your teacher to explain how he or she plans lessons that contain a lot of factual information.

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Long-Term Memory Activities

Select several unrelated objects, such as a can opener, a tennis ball, a drinking cup, a stapler. Place one on a table in the front of the room screened from your classmates' view. Ask a classmate to come to the front of the room and describe the object in one minute without saying its name or what it is used for. Ask your classmates to write down what they think it is, and then show them the object. How many got it correct? What descriptors helped the most? The least? Repeat the task with other classmates and objects. Note if the descriptions and student guesses get better over subsequent trials.

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Long-Term Memory Activities
Audiotape or Camcorder Required

Older people often say that their memory isn't as good as it once was. Interview several older people, and ask them what kinds of memory tasks they now find more difficult than they did when they were younger. What do they do to remember something important that they might forget? Play the tape to the class.

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Long-Term Memory Activities
Audiotape or Camcorder Required

Interview several teachers in your school about what they think are the easiest and most difficult things for students to learn. Play the tape to the class.

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Long-Term Memory Activities
Audiotape or Camcorder Required

Interview a history teacher or a person who is especially interested in history about the role that history plays as a memory system for our society. Why should we study history? What happens to a society that ignores its history (memory)? Play the tape to the class.

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Long-Term Memory Activities
Audiotape or Camcorder Required

Interview musicians about (1) how they memorize a musical work and (2) how playing memorized music differs from improvising music. Play the tape to your class.

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Skill Memory Activities

Ask classmates to stand still and grasp their hands behind their backs, then to explain how to do something such as tying shoes, getting on a bike, walking, roller skating.

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Skill Memory Activities

Ask people who are good at a skill to explain how they do the act without really thinking about what they're doing: ask people who can play an instrument such as a piano or guitar to explain how they remember what to do with their hands when they're reading music, people who can touch type to explain how they do it, people who drive a car to explain how they steer in and out of busy traffic, and so on. Give a class report on what they said.

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Skill Memory Activities

Ask a series of classmates to orally spell increasingly longer words backward, such as *cat, jack, blind, bounce, reports, observed, platforms.* Use a stopwatch to time how long it takes for each word, and how many errors they make. Did you discover a word length at which the task gets especially difficult for most students? Ask your classmates to explain how they did it. You might also ask them to say their telephone number and the alphabet in reverse order. Give a class report on what you discovered about things that our brain does easily in only one direction. Can anyone in the class sing or hum a song backwards?

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A Memory Game

The game Gossip has the players sit in a circle, listen to a whispered sentence, and then whisper it to the next player in sequence. For example, "Seven old blue elks roamed over the snow-covered meadow during a warm July afternoon." The last person says the sentence out loud, and it's usually quite different from the original sentence.

In this version, each player whispers the sentence simultaneously into the next player's ear *and a tape recorder.* When everyone has had a turn, play the tape to discover how and when the sentence shifted.

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A Memory Game

A visual variation of the game uses a single crayon or marking pen to draw a simple line picture on a piece of gray or light brown construction paper (a simple house, tree, flowers, bird, and so on). Ask classmates in turn to (1) look at the picture for five seconds, then (2) draw what they remember of the picture on another sheet of construction paper that you quickly place on top of the original picture. It's important to use paper thick enough so that they can't see the drawing under it. Repeat with another classmate who will look at the first classmate's drawing for five seconds before trying to reproduce it. Continue the process with all classmates, then display the pictures in sequence. Note how and when the picture changed.

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Using Overheads and Handouts

You may make the illustrations on the next five pages into overheads or handouts to help you present the information covered in this kit in an interactive manner. Following is a brief desciption of each, as well as suggestions for using them all in the classroom.

Overhead 1 is a flow chart of text. It shows that memory is the result of a series of processes that begins with our senses taking in information. A more detailed explanation of this phenomenon begins on page 5.

Overhead 2 is of a boy who sees a menacing shadow. Remind the class that if the information is important to us—that is, linked to an emotion—then we focus on it. We can pay attention to only a small fraction of the information available to us, so we select what is meaningful. The meaning might be linked to our survival.

Ask the group to guess what is happening in this picture. How would they react in a similar situation? In this case, the menacing shadow triggers our survival response. All other information drops away and we focus on the shadow. If we hear footsteps approaching, we would focus on that sound, as well. Other sights, sensations, and sounds would fade into the background. Our memory for this experience will probably be short term if the shadow and footsteps turn out to be those of a friend. If the event is one that really is a threat, however, the information will be stored in our long-term memory. In that case, future experiences where we see similar shadows or hear footsteps would trigger a response based on the memory of the original event. Even walking through the same neighborhood at night would be likely to bring the original event to mind.

The explanation for this illustration is also included in the second segment of side 2 of the audiotape. You might play the segment for your students or make it available for individual students as a reminder of the information you present in class.

Overhead 3 provides an example of the way in which song triggers memory. Most students relate to the way in which particular songs remind them of specific events or times in their lives. When that certain tune plays, our attention focuses there and other sounds, such as a dog barking, other people talking, or a plane flying overhead, fade into the background. The song opens an "emotional file folder" in which other, similar memories are stored. If, on the other hand, the song is one to which we have no emotional connection, then it might hold our attention only briefly.

Consider inviting students to bring favorite songs to class; play a section of one song each day. Students write down the emotion they associate with the song. Our emotional responses and memories are varied and unique. This exercise demonstrates that we each build unique memories and associations.

Overhead 4 presents one situation that might evoke anger. Invite students to discuss other such situations. The pain of being hit by a baseball might trigger anger, although if the person who threw it were to apologize and explain that it was an accident, one might be able to let go of the anger. The experience of being hit would probably be stored in long-term memory and might be recalled years later. Ask the class what events might trigger this memory. For example, the memory might return if you saw a baseball, or any object, heading your way, or if you were hit in the head again.

If the person in this illustration has been hit before by someone who loses her temper and then apologizes, the baseball incident might open an emotional file folder where many memories associated with anger are stored. In this case, it might be more difficult to let go of the anger and accept the apology.

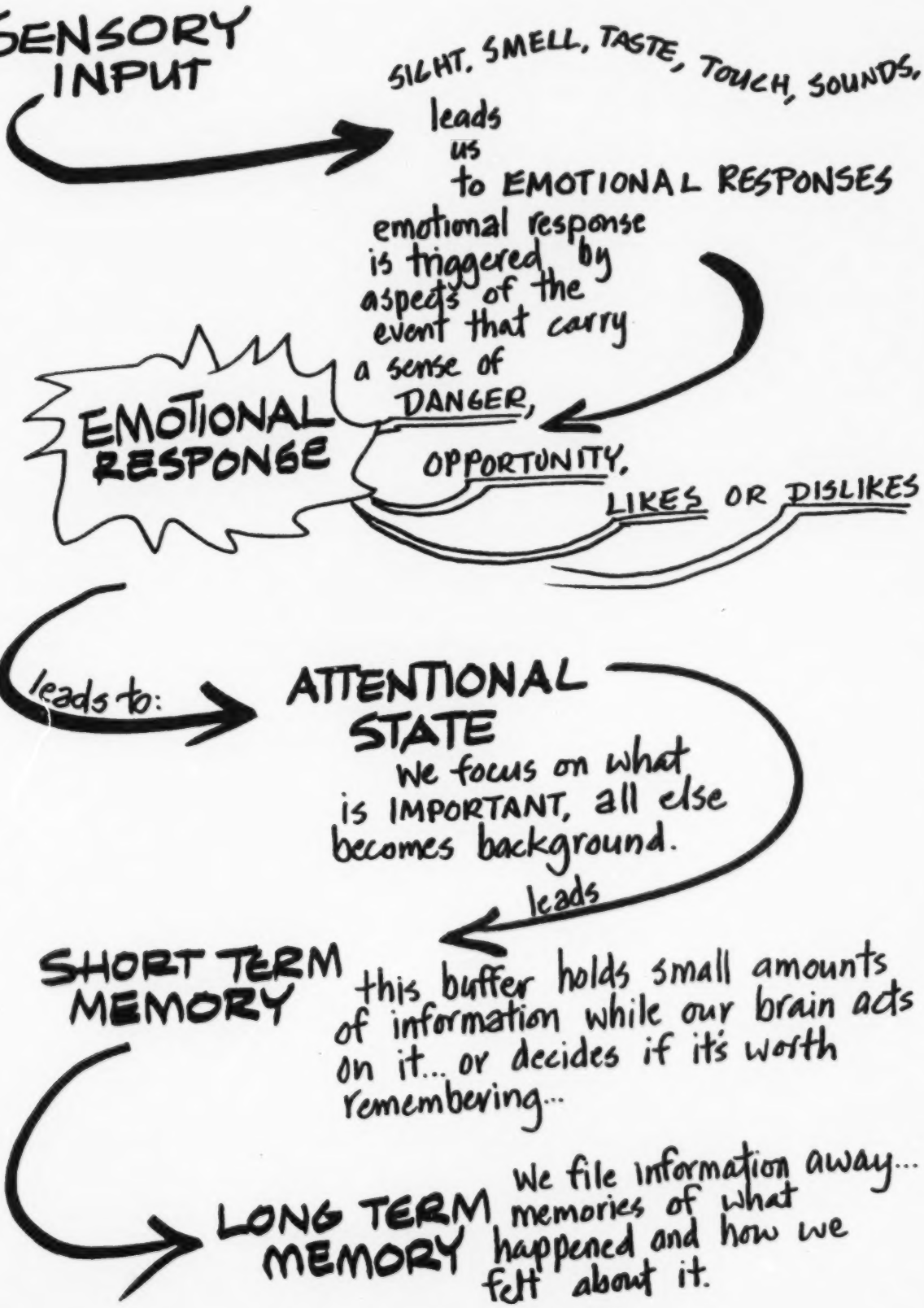
Overhead 5 is designed for the class to fill in with examples of their own. The events and emotions can be fictional or can come from their own lives.

A Final Note

This kit has been designed to enable students to learn about memory and learning through a variety of engaging, multisensory activities. The overhead transparency masters that follow are intended to help you do so. We trust that you will create your own adaptations and variations and invite you to contact us to share your ideas and applications. In this manner we, as adults and colleagues, can continue to learn from one another.

Memory, © 1998 Zephyr Press, Tucson, Arizona

Overhead 1


SENSORY INPUT
SIGHT, SMELL, TASTE, TOUCH, SOUNDS,
leads us to EMOTIONAL RESPONSES
emotional response is triggered by aspects of the event that carry a sense of
DANGER,
OPPORTUNITY,
LIKES OR DISLIKES
EMOTIONAL RESPONSE
leads to:
ATTENTIONAL STATE
We focus on what is IMPORTANT, all else becomes background.
leads
SHORT TERM MEMORY
this buffer holds small amounts of information while our brain acts on it... or decides if it's worth remembering...
We file information away... memories of what happened and how we felt about it.
LONG TERM MEMORY

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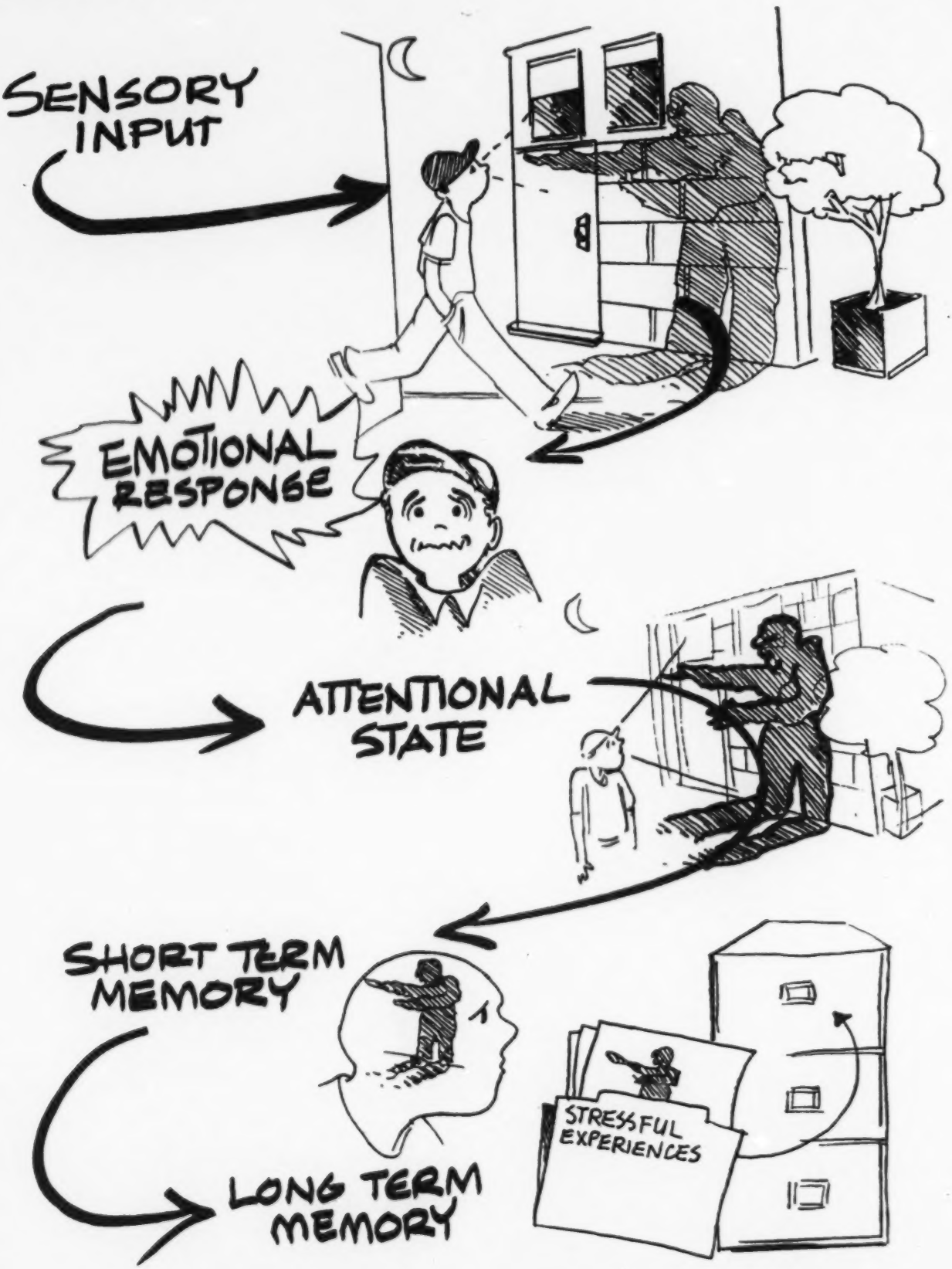
Overhead 2



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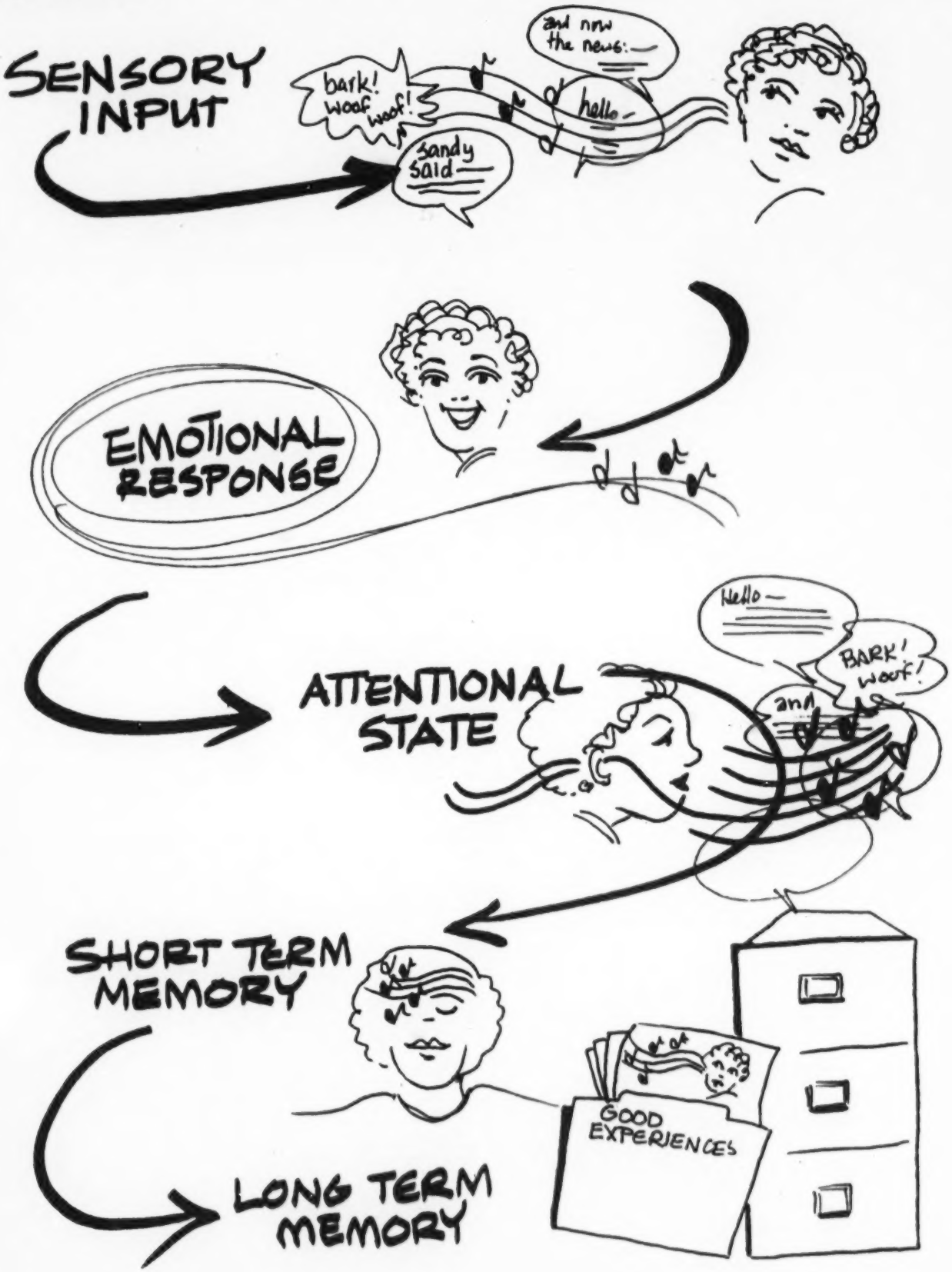
Overhead 3



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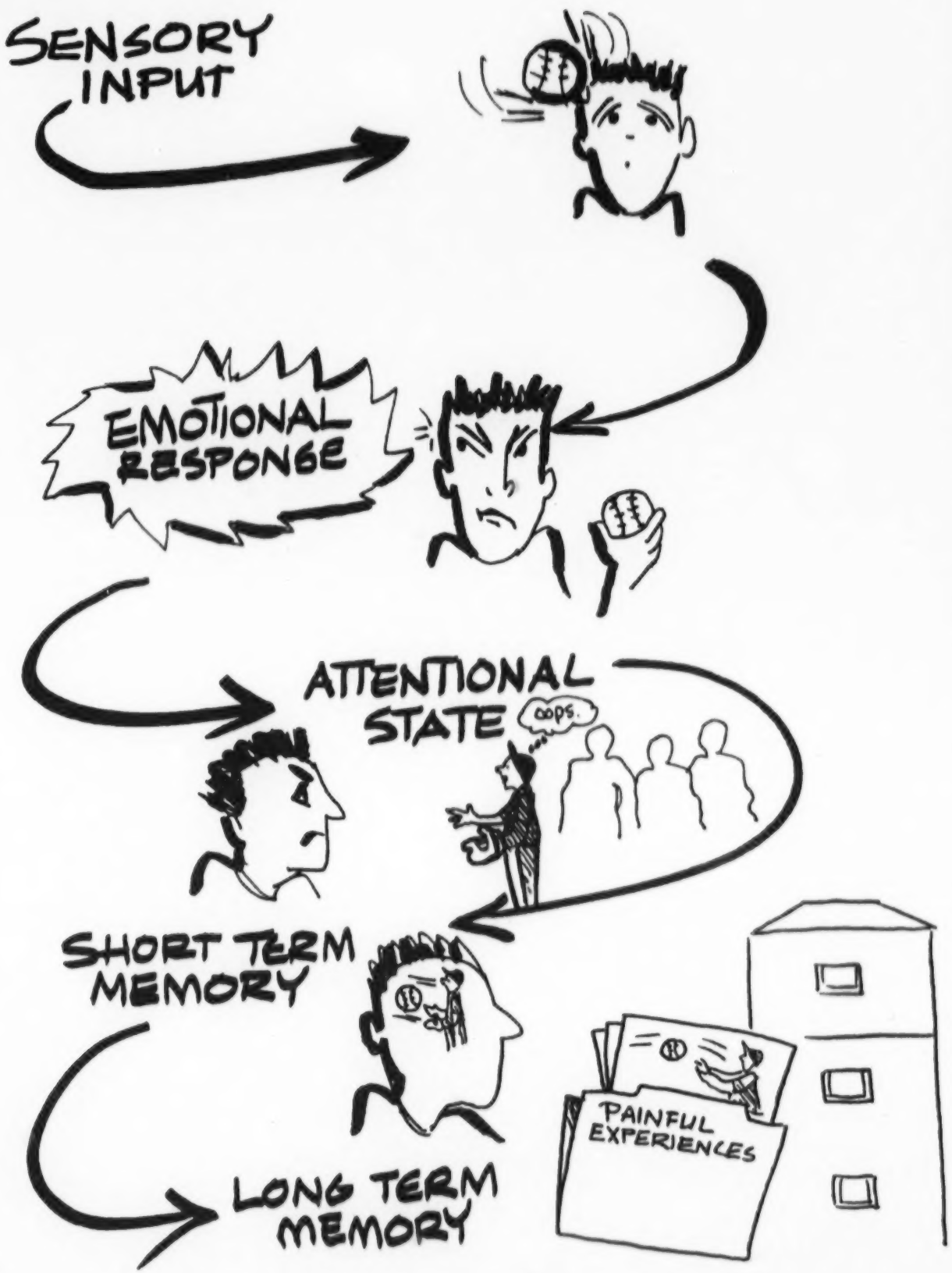
Overhead 4



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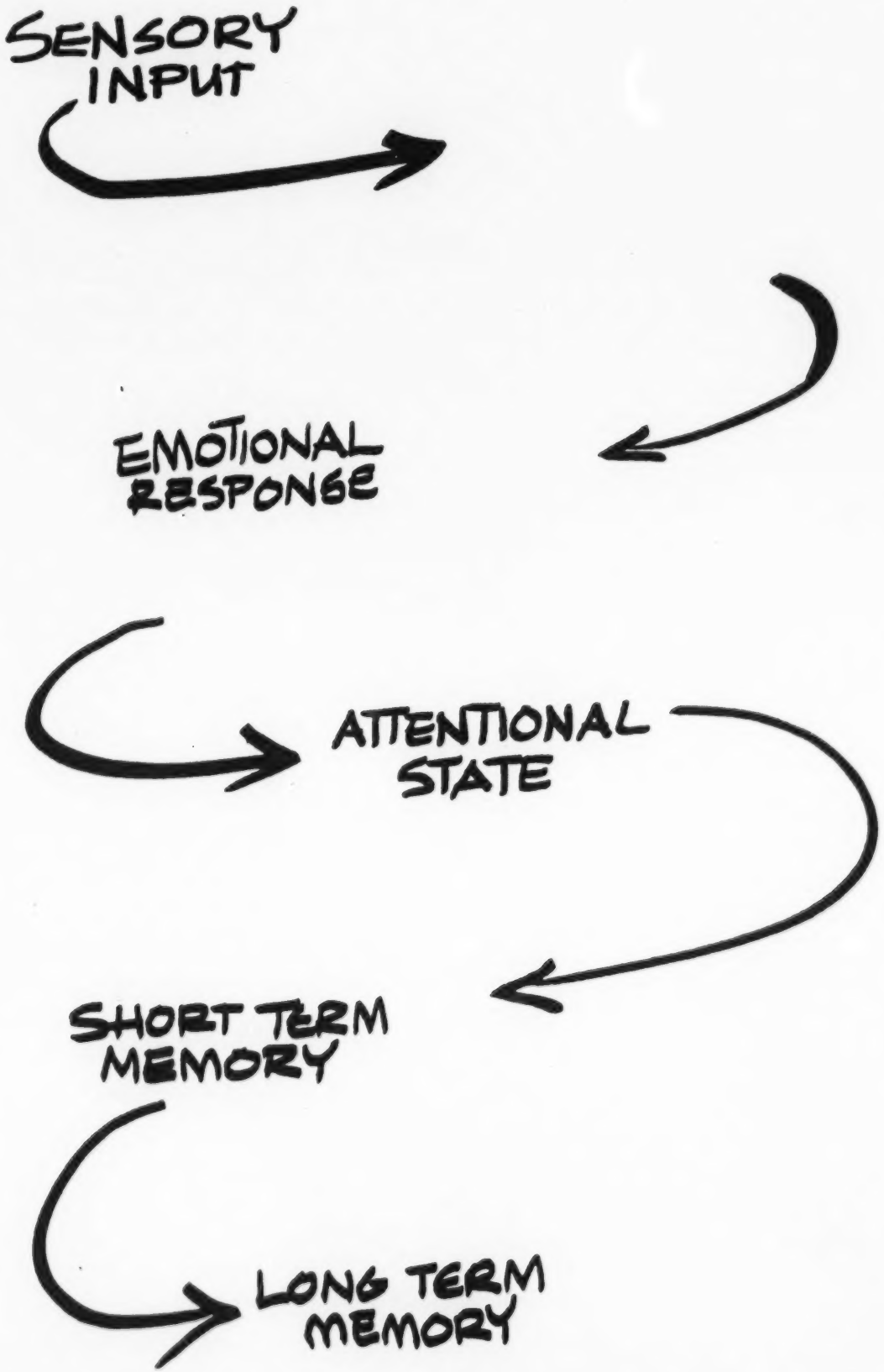
Overhead 5



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See especially chapter 5, "How Our Brain Learns, Remembers, and Forgets."

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